

FURTHER REMARKS ON THE IDENTITY OF
SUDANONAUTES ORTHOSTYLIS BOTT, 1955,
(CRUSTACEA: DECAPODA: POTAMOIDEA: POTAMONAUTIDAE)
WITH COMPARISONS WITH OTHER SPECIES
FROM NIGERIA AND CAMEROON

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Abstract.—*Sudanonautes orthostylis* Bott, 1955 a freshwater crab from West Africa is redescribed exclusively from type material. The species is now recognized by a combination of characters of the carapace, chelipeds, and gonopods, which are illustrated. It is compared to other species of *Sudanonautes* Bott, 1955, and to the other genera of freshwater crabs occurring in West Africa. The species is restricted to the tropical rain forest zone of southwest Cameroon, West Africa.

The rain forest region of southeast Nigeria and southern Cameroon is home to a large number of species of freshwater crabs of the family Potamonautidae Bott, 1970 (Bott 1955, 1959, 1964; Monod 1977, 1980; Cumberlidge 1989, 1991, 1993a, b; Cumberlidge & Clark 1992). These crabs belong to either *Potamonautes* MacLeay, 1838, *Sudanonautes* Bott, 1955, or *Potamonemus* Cumberlidge & Clark, 1992. Those species which possess one or more side spines on the carapace and an elongated, flagellum-like terminal segment of gonopod 2 belong to *Potamonautes*. Several other species of small-bodied freshwater crabs have a carapace lacking side spines and a second gonopod with a short terminal segment. Those with a third maxilliped whose exopod lacks a flagellum belong to *Potamonemus*, while crabs which possess this flagellum belong to *Sudanonautes*.

However, identification of the similar-looking members of *Sudanonautes* found in the rain forest zone of Nigeria and Cameroon is hampered by the lack of a reliable taxonomic key to the species. The current literature (Bott 1955, 1964; Monod 1980; Cumberlidge 1989, 1993a) records five species of *Sudanonautes* found in this region:

S. pelii (Herklots, 1861), *S. aubryi* (H. Milne-Edwards, 1853), *S. africanus* (A. Milne-Edwards, 1869), *S. orthostylis* Bott, 1955, and *S. granulatus* (Balss, 1929).

Sudanonautes orthostylis was first described by Bott (1955) as a subspecies of *S. decazei*. That work included photographs of the carapace and chelipeds of the holotype from Cameroon and a sketch of the terminal segment of gonopod 1. In a later work, Bott (1964) considered *S. (S.) d. decazei* as a junior synonym of *S. pelii* without discussion of the subspecies. *Sudanonautes pelii* (Herklots, 1861) and *S. decazei* (A. Milne-Edwards, 1886) are synonymous taxa (Cumberlidge 1989), but *S. orthostylis* does not appear to be closely related to *S. pelii*, as this study will show. As such, there is a need to establish the identity and affinities of *S. (S.) decazei orthostylis* Bott, 1955.

This anomaly prompted Cumberlidge (1989) to redescribe *S. orthostylis* Bott, 1955, based on a large male specimen from the Oban Hills, Nigeria, as well as numerous additional material from that country. Cumberlidge (1989) ascribed differences between specimens of *S. orthostylis* from different localities in Nigeria to intraspecific variation. Subsequent examination of this

Nigerian material in the light of recent findings (Cumberlidge & Clark 1992; Cumberlidge 1993a, 1993b) indicates that part of this material should be removed from *S. orthostylis* and reassigned to *Sudanonautes granulatus* (Balss, 1929), and part to a species of *Potamonemus*.

These developments have made it necessary to clarify the taxonomy of *S. orthostylis* by describing the species exclusively from the holotype and paratypes from Cameroon. The taxonomically important characters of the carapace, chelipeds, mandible, third maxilliped, and gonopods are illustrated. The species is compared to other species of *Sudanonautes* Bott, 1955, and to the other genera of freshwater crabs occurring in West Africa.

Methods

The type series of *S. orthostylis* Bott, 1955 was examined during a visit to the Zoologische Museum der Humboldt-Universität, Berlin, Germany (ZMB), and the holotype was subsequently loaned. Two other paratypes were examined during a visit to the Natur-Museum und Forschungs-Institut Senckenberg, Frankfurt am Main, Germany (SMF). The type specimen of *S. pelii* was loaned from the Nationaal Natuurhistorisch Museum, Leiden, The Netherlands (NNM). The type specimens of *S. africanus* and *S. aubryi* were examined in the Museum National d'Histoire Naturelle, Paris, France (MNHN). Large series of these latter two species from other collections were also examined. Four dimensions of the carapace, carapace length, carapace width, carapace height, and front width, were recorded from each specimen using digital calipers (Table 1, Fig. 3a). The relative proportions of the latter three measurements (adjusted for body size, CL) of *S. orthostylis* were calculated (Fig. 3b). These proportions were also calculated for the series of the other three species of *Sudanonautes*. One-factor ANOVA repeated measures analysis was used to test

for significant differences between the mean of the carapace proportions of *S. orthostylis* and the three closely related species (Table 2). The right mandible and the left first and second gonopods were removed from the specimens in order to describe these structures from different views. The length of the propodus of the right and left chelipeds of males and females was measured longitudinally along the ventral margin.

Abbreviations. — CW = carapace width at widest point; CL, carapace length, measured along median line; CH, carapace height, maximum depth of cephalothorax; FW, front width, width of front measured along anterior margin.

Sudanonautes orthostylis Bott, 1955 (Figs. 1–3, Tables 1, 2)

Sudanonautes (Sudanonautes) decazei orthostylis Bott, 1955:301, fig. 63a, b; pl. 29, fig. 2a–d.

Sudanonautes (Sudanonautes) pelii pelii Bott, 1964:32 (part) (not *Cancer (Thelphusa) pelii* Herklots, 1861).

Sudanonautes orthostylis, Cumberlidge, 1989:230 (part), figs. 1a–g, 2a–c.

Material. — Holotype: male (CW 25.8 mm), Bipindihof, Cameroon, collected by Zenker, ZMB 11093. Paratypes: 8 males, 3 females, 3 juveniles; ZMB 11093, SMF 2439.

Type locality. — Bipindihof, Cameroon. This locality is most likely Bipindi (3°08'N, 10°30'E).

Diagnosis. — Terminal segment of gonopod 1 straight for most of its length, curving sharply outward just before tip; completely lacking longitudinal groove; subterminal segment of gonopod 1 slim (Fig. 2f–h); terminal segment of gonopod 2 extremely short (Fig. 2i). Major cheliped of adult male longer, higher than minor cheliped (Fig. 2a, b, Fig. 1a). Dactylus of major cheliped of adult male broad, flat; dactylus, pollex enclosing long narrow interspace along their cutting

Table 1.—*Sudanonautes orthostylis* from Cameroon, West Africa. Carapace dimensions (mm) and proportions relative to body size (CL) of the type series. (M = male, F = female, ad = adult, juv = juvenile, $n = 14$.)

Sex	CW	CL	CH	FW	CW/CL	CH/CL	FW/CL
Holotype, ZMB 11093							
M	25.8	18.1	8.5	7.8	1.43	0.47	0.43
Paratypes, ZMB 11093							
M	27.8	17.6	9.5	8.8	1.58	0.54	0.50
M	27.4	18.6	8.9	7.9	1.47	0.48	0.42
M	23.7	16.5	8.9	7.7	1.44	0.54	0.47
M	22.8	15.5	8.0	7.2	1.47	0.52	0.46
M	21.7	15.2	7.2	6.9	1.43	0.47	0.45
M	21.7	15.7	7.2	7.2	1.38	0.46	0.46
M	18.2	12.7	6.1	6.3	1.43	0.48	0.50
F (ad)	22.1	16.0	8.7	7.0	1.38	0.54	0.44
F (juv)	19.2	13.0	7.1	6.6	1.48	0.55	0.51
F (juv)	16.7	11.6	5.6	5.6	1.44	0.48	0.48
F (juv)	13.3	9.7	4.6	4.6	1.37	0.47	0.47
Paratypes, SMF 2439							
M	23.0	16.5	8.5	7.5	1.39	0.52	0.45
F (ad)	28.0	18.5	10.0	9.5	1.51	0.54	0.51

edges when fingers closed (Fig. 2a). Carpus of cheliped with 2 large pointed teeth, second smaller than first (Fig. 2c). Carapace distinctly convex, about half carapace length (Table 2); carapace, anterolateral margin, lower margin of orbit, postfrontal crest (i.e., fused epigastric, postorbital crests), smooth (Fig. 1a, b). Small intermediate tooth on anterolateral margin between exo-orbital and epibranchial teeth (Fig. 1b); vertical suture on flank meeting anterolateral margin at epibranchial tooth (Fig. 1b). Small species, mature at CW 22.0 mm.

Description of holotype – Carapace (Fig. 1a, b).—Ovoid, widest in anterior third (CW/CL = 1.43), relatively high, with maximum height in anterior region (CH/CL = 0.47). Anterior margin of front straight, curving under, front relatively narrow, about one-third carapace width (FW/CW = 0.30). Surface of carapace smooth with no deep grooves. Postfrontal crest consisting of fused epigastric, postorbital crests, smooth, ending before meeting anterolateral margins; mid-groove broad, shallow. Exo-orbital tooth blunt, low, intermediate tooth pres-

ent, small low, epibranchial tooth small, low. Anterolateral margin of carapace smooth. Posterolateral margin curving inward, continuous with anterolateral margin. Posterior margin about two-thirds as wide as carapace width.

Each flank with 2 sutures, 1 longitudinal, 1 vertical, dividing flank into 3 parts (Fig. 1b). Longitudinal suture dividing suborbital, subhepatic regions from pterygostomial region, beginning at respiratory opening and curving backward across flank. Short vertical suture dividing suborbital region from subhepatic region (Fig. 1b); suture beginning just beneath epibranchial tooth, curving down to meet longitudinal flank groove, marked by row of small rounded teeth. Groove between sternal segments 2 and 3 complete; groove between sternal segments 3 and 4 consisting of 2 small notches at sides of sternum (Fig. 1d). Third maxillipeds filling entire oral field, except for transversely oval efferent respiratory openings at superior lateral corners. Flagellum on exopod of third maxilliped (Fig. 1c). Ishium of third maxilliped smooth, with faint vertical

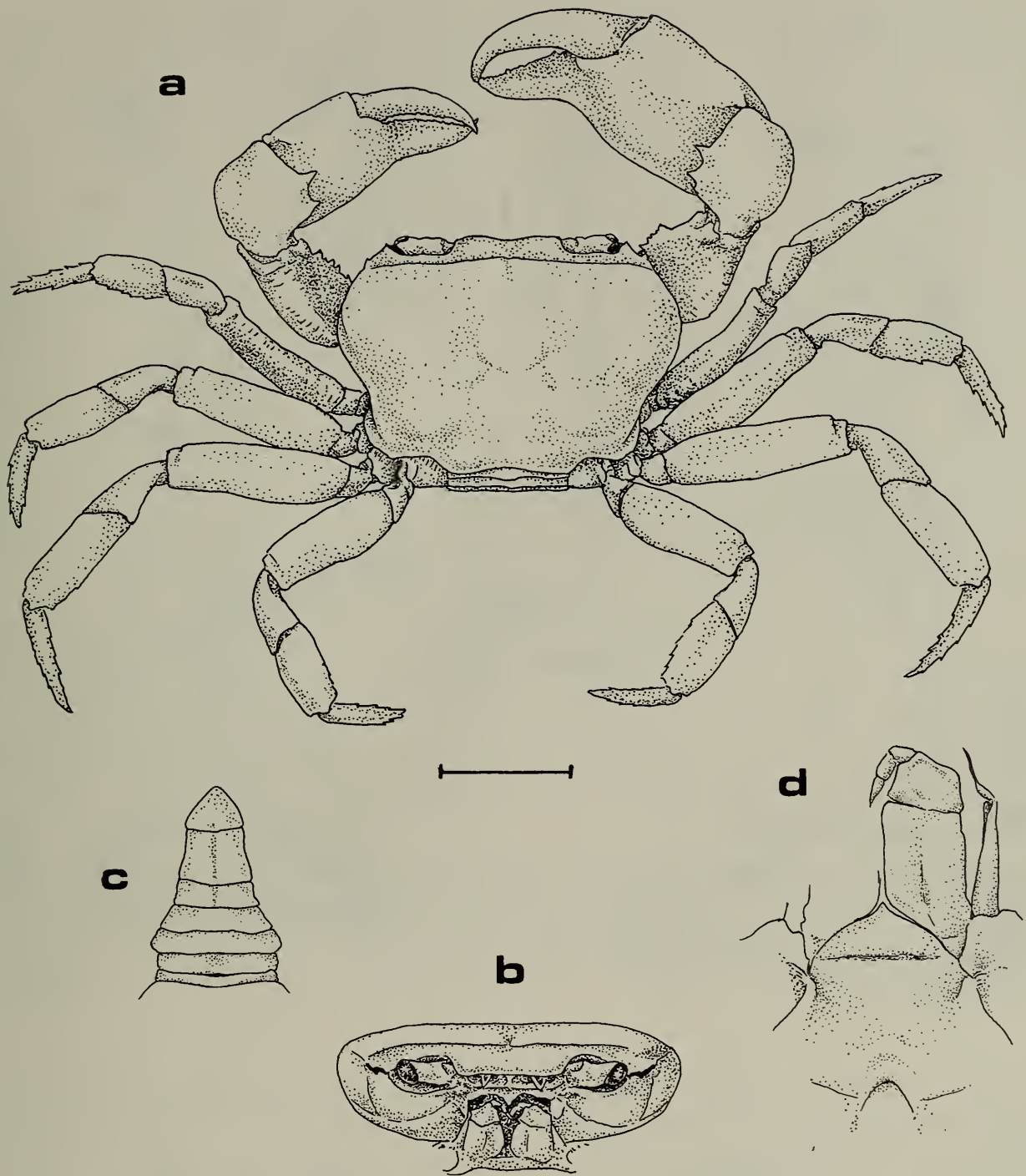


Fig. 1. *Sudanonautes orthostylis*, adult male from Bipindihof, Cameroon (CW 25.8 mm), ZMB 11093. a, whole animal, dorsal aspect; b, cephalothorax, frontal aspect; c, abdomen; d, left third maxilliped and detail of sternum. Scale bar equals 10.00 mm (a, b, d), and 5.0 mm (c).

groove (Fig. 1c). Mandibular palp 2-segmented; terminal segment single, undivided, small hard, flap at junction between segments (Fig. 2d, e). First 5 segments of male abdomen broad, short, tapering inward; last 2 segments long, narrow, last segment rounded at distal margin (Fig. 1c).

Chelipeds (Figs. 1a, 2a–c).—Unequal, right

longer (23.5 mm), higher (12.0 mm) than left (18.0 mm, 7.0 mm respectively). Dactylus of right cheliped broad, flattened, fingers enclosing long narrow interspace when closed, palm of propodus swollen. Fingers of right cheliped with series of small pointed teeth along length. Anterior dorsal margin of merus of right and left chelipeds with

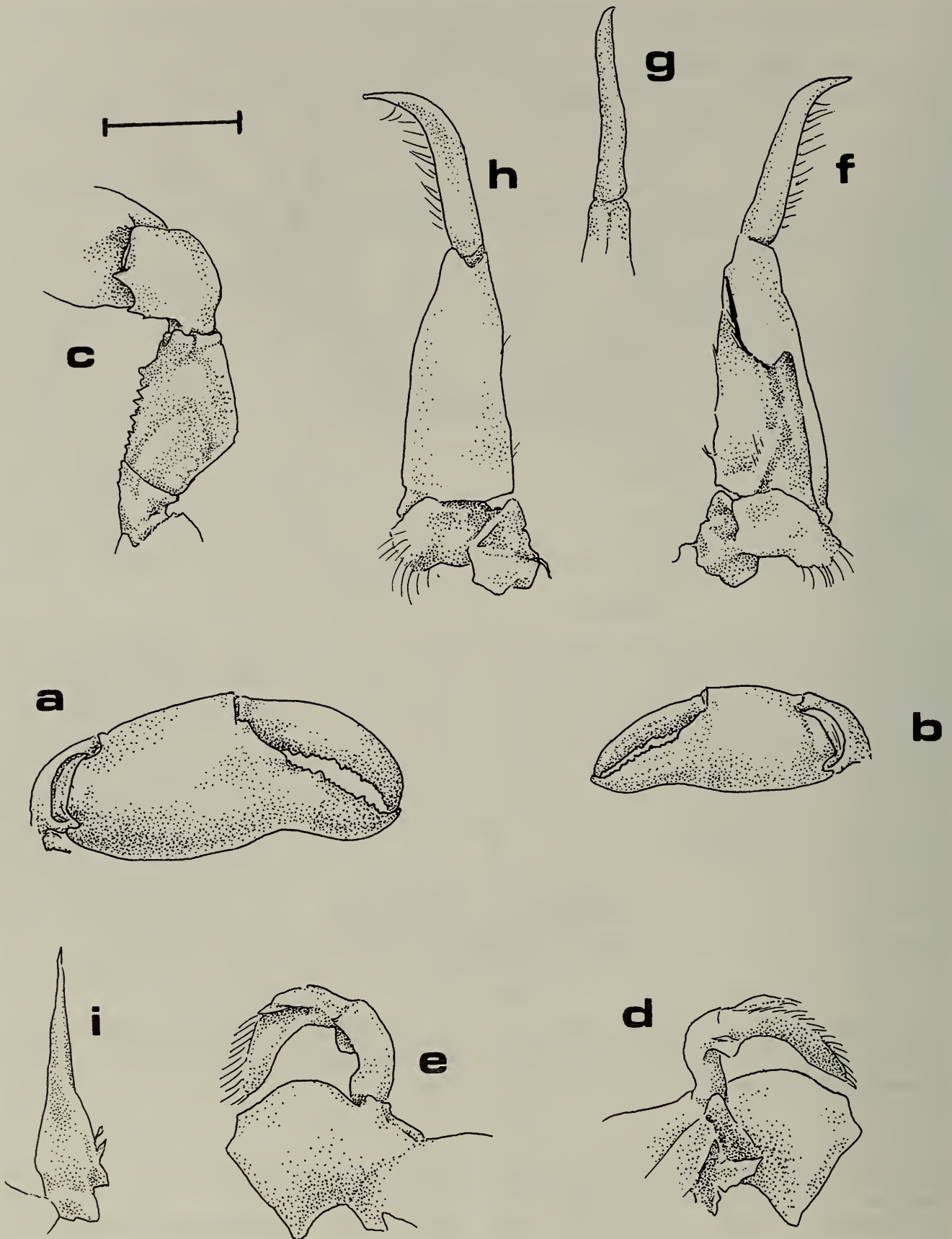


Fig. 2. *Sudanonautes orthostylis*, adult male from Bipindihof, Cameroon (CW 25.8 mm), ZMB 11093; a, right cheliped, frontal view; b, left cheliped, frontal view; c, detail of carpus and merus of right cheliped, dorsal view; d, right mandible anterior view; e, right mandible posterior view; f, left gonopod 1, caudal view; g, distal portion of left gonopod 1 turned to show medial margin; h, left gonopod 1, cephalic view; i, left gonopod 2, caudal view. Scale bar equals 10.00 mm (a-c), and 2.0 mm (d, e, f-i).

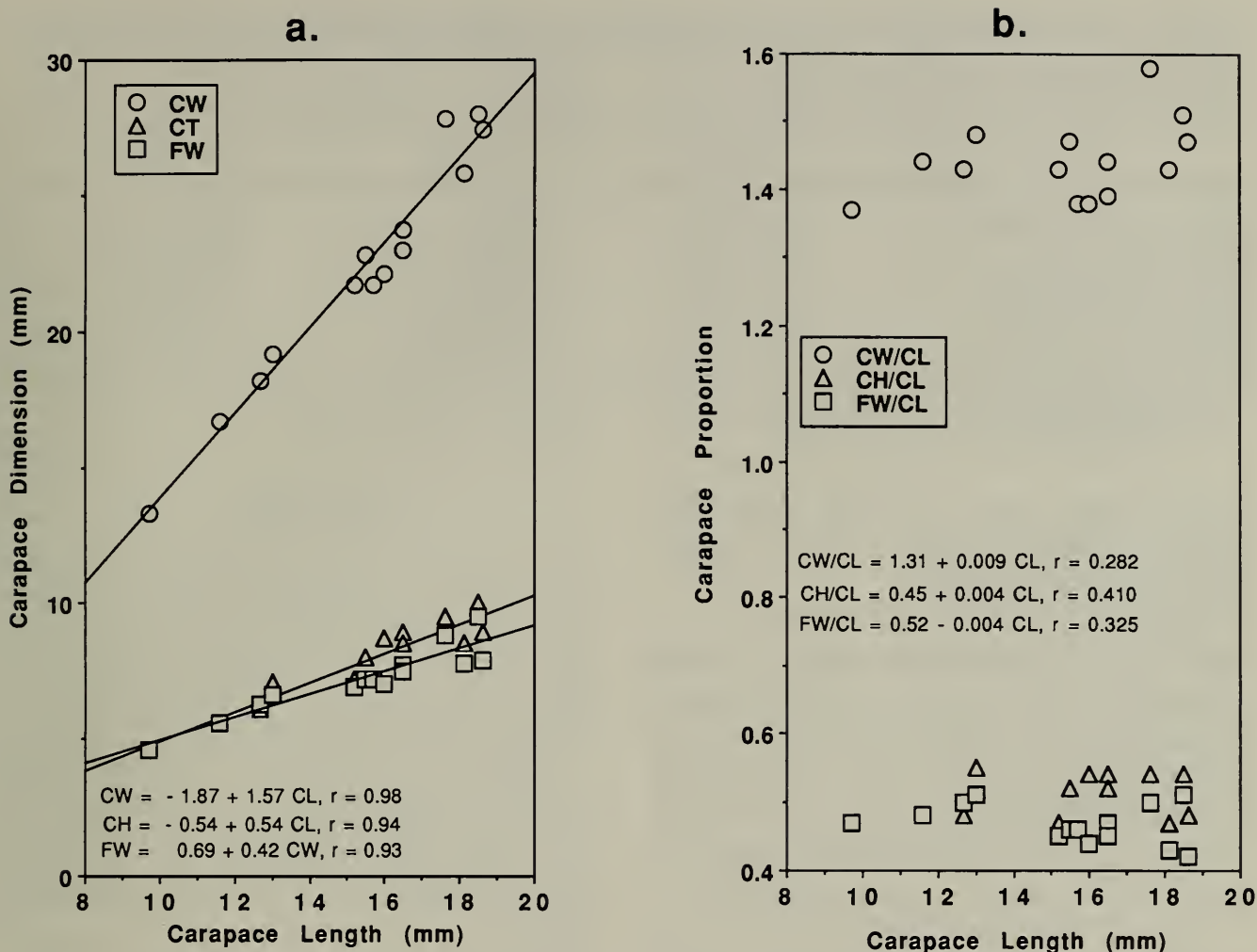


Fig. 3. Comparisons of 14 specimens of *Sudanonautes orthostylis* from Bipindihof, Cameroon. a, dimensions of the carapace (CW, CH, FW) compared to body size (CL), *r* values (all at *df* = 13) indicating highly significant correlation (*P* < 0.001) between size classes. b, relative proportions of the carapace (CW/CL, CH/CL and FW/CL) compared to body size (CL), *r* values (all at *df* = 13) indicate no significant correlation (*P* > 0.01) between size classes.

rows of small pointed teeth, largest close to distal end. Carpus of cheliped with 2 large pointed teeth on inner margin, second smaller than first. Left cheliped similar to right, but smaller in all respects. Walking legs (pereopods 2–5) slender, P4 longest, P5 shortest. Dactyli of P2–5 tapering to point, each bearing rows of downward-pointing sharp bristles; dactylus of P5 shortest of the 4 legs.

Gonopods. — Terminal segment of gonopod 1 straight for most of its length, curving sharply outward just before tip; lacking longitudinal groove; lateral margins fringed by sparse bristles; subterminal segment gonopod 1 slim narrowest at junction between

segments, widest at basal end (Fig. 2f–h). Caudal face of subterminal segment forming raised triangular flap extending halfway across segment, flap tapering diagonally to point at junction with terminal segment, forming roof of chamber for gonopod 2; cephalic face of subterminal segment narrow, forming lower floor of chamber for gonopod 2.

Gonopod 2 (Fig. 2i) shorter than gonopod 1 (reaching only junction between last 2 segments of gonopod 1). Terminal segment gonopod 2 extremely short, only 1/10 as long as subterminal segment; terminal segment with pointed tip. Subterminal segment gonopod 2 widest at base, tapering gradually

Table 2.—Means ($\pm SD$) of ratio of carapace width (CW), carapace height (CH), and front width (FW), to body size (CL) of *Sudanonautes orthostylis* compared to four closely related species of *Sudanonautes* from Cameroon and Nigeria, ($n = 14$ in all cases).

	CW/CL $\bar{X} \pm SD$	CH/CL $\bar{X} \pm SD$	FW/CL $\bar{X} \pm SD$
<i>Sudanonautes orthostylis</i>	1.44 \pm 0.1	0.50 \pm 0.03	0.47 \pm 0.03
<i>Sudanonautes pelii</i>	1.37 ^a \pm 0.1	0.49 \pm 0.02	0.40 ^a \pm 0.01
<i>Sudanonautes africanus</i>	1.37 ^a \pm 0.1	0.40 ^a \pm 0.1	0.40 ^a \pm 0.1
<i>Sudanonautes aubryi</i> ^b	1.52 ^a \pm 0.1	0.61 ^a \pm 0.1	0.38 ^a \pm 0.1
<i>Sudanonautes granulatus</i>	1.40 ^a \pm 0.1	0.52 ^a \pm 0.1	0.39 ^a \pm 0.1

^a Proportion significantly different from that of *S. orthostylis* at 95% confidence limits.

^b Adult specimens only, all from Nigeria.

inward along length, forming long, thin, pointed, upright process which supports short terminal segment.

Adult female paratype (CW 22.0 mm, Tables 1, 2).—Anterolateral margin behind epibranchial tooth bearing row of small, rounded low teeth. Right, left chelipeds same proportions as male of same size, unequal in both length (20.0 mm, 13.0 mm), height (9.0 mm, 5.0 mm). Mature female abdomen very wide reaching coxae of pereopods 2–5. Segments of female abdomen becoming gradually longer distally, first, fifth becoming gradually wider, abdomen being widest at line separating fourth, fifth segments. Sixth segment, telson together forming near semicircle.

Juvenile and pubertal size classes (Fig. 3a, b, Tables 1, 2).—Sexual maturity judged by development of female abdomen: abdomen of mature females overlapping bases of coxae of walking legs; pleopods broad, hair-fringed. Pubertal molt, from pubertal stage to sexual maturity, occurring after CW = 22.0 mm. Dimensions of the carapace varying with age (Fig. 3a). Relative proportions of carapace (width, CW/CL, height, CH/CL, width of frontal margin, FW/CL) of juvenile, pubescent *S. orthostylis* not significantly different from adults (Fig. 3b).

Size.—Measurements given in Table 1.

Distribution.—*Sudanonautes orthostylis* is known only from the rivers and streams of the rain forests of south west Cameroon.

Discussion

A number of species of freshwater crabs from the forested regions of Cameroon and Nigeria bear a superficial resemblance to the holotype of *S. orthostylis* from Cameroon. Included in this group are *S. pelii*, *S. aubryi*, *S. africanus*, *S. granulatus*, and the three species of *Potamonemus* (Cumberlidge & Clark 1992, Cumberlidge 1993b). These taxa can be distinguished from *S. orthostylis* as follows.

Comparison of *S. orthostylis* from Cameroon with the lectotype of *S. pelii* from Elmina, Ghana revealed the following differences: (1) the terminal segment of gonopod 1 of *S. orthostylis* is straight, curving sharply at its tip, while that of *S. pelii* is curved evenly along its entire length; (2) the dactylus of the major cheliped of *S. orthostylis* is broad and flat, while that of *S. pelii* is narrow and slightly arched; (3) the post-frontal crest of *S. orthostylis* almost meets the anterolateral margin close to the epibranchial tooth, while that of *S. pelii* meets this margin behind the epibranchial tooth; (4) the carapace and frontal margin of *S. orthostylis* are significantly wider than those of *S. pelii* (Table 2); and (5) *S. orthostylis* is a much smaller species maturing at CW 22.0 mm, compared to maturity at CW 45.0 mm in the larger *S. pelii*.

A smooth rounded carapace is a character shared by both *S. orthostylis* and *S. aubryi*.

The two taxa may be distinguished as follows: (1) the terminal segment of gonopod 1 of *S. orthostylis* lacks a groove, is straight, and curves sharply outward at the tip, while that of *S. aubryi* bears a longitudinal groove and curves along its entire length; and (2) the carapace of *S. orthostylis* is significantly flatter and less widened, and the frontal margin is wider than those proportions of *S. aubryi* (Table 2).

Sudanonautes orthostylis may be distinguished from *S. africanus*, the type species of the genus as follows: (1) gonopod 1 of *S. orthostylis* is straight, curving only at the tip, while that of *S. africanus* curves evenly along its length; (2) the dactylus of the major cheliped of *S. orthostylis* is broad and flat and the propodus lacks large teeth, while the dactylus of *S. africanus* is slightly arched and the propodus possesses a diagnostic broad, flat tooth; (3) the carapace of *S. orthostylis* is smooth, while that of *S. africanus* has a warty texture in the posterior region, and distinct granulations in the anterior corners; (4) the carapace of *S. orthostylis* is significantly higher and wider, and the frontal margin is wider than in *S. africanus* (Table 2); and (5) *S. africanus* is a much larger species than *S. orthostylis* maturing at CW 70.0–90.0 mm, rather than around CW 22.0 mm for *S. orthostylis*. Specimens of *S. orthostylis* of CW 25.0 mm or more show greatly enlarged chelipeds (male) and broadened abdomen (female), whereas the chelipeds and abdomen of *S. africanus* of this size are small and undeveloped (i.e., juveniles).

Sudanonautes orthostylis may be distinguished from *S. granulatus* (Balss, 1929) [(fide Cumberlidge 1933a)] as follows: (1) the proximal two-thirds of the terminal segment of gonopod 1 of *S. orthostylis* is straight, lacks a groove, and curves sharply outward at the tip, whereas that of *S. granulatus* curves along its entire length, and the gonopod bears a longitudinal groove; (2) the vertical suture on the flank of *S. orthostylis*

originates at the epibranchial tooth, whereas that of *S. granulatus* originates at the intermediate tooth; (3) the dactylus of the major cheliped of the adult male of *S. orthostylis* is broad and flat, but not arched, whereas that of *S. granulatus* is narrow and dramatically arched; (4) the major cheliped of adult *S. granulatus* is longer than the carapace width, whereas that of *S. orthostylis* is shorter than the carapace width; and (5) the carapace and the frontal margin of *S. orthostylis* are significantly wider than in *S. granulatus* (Table 2).

The short terminal segment of gonopod 2 of the species of *Potamonemus* resembles that of *S. orthostylis* but the lack of a flagellum on the exopod of the third maxilliped of *Potamonemus* and the absence of a well-defined intermediate tooth on the anterolateral margin of the carapace clearly separate the 2 genera (Cumberlidge & Clark 1992, Cumberlidge 1993b).

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